Supplementary discussion

Relation to previous studies on probability distortion

The present results help to explain and specify some of the previously reported data (Paulus and Frank, 2006; Berns et al., 2008). Specifically, the current data suggest that probability distortions occur with rewarding outcomes and are not explained by attentional mechanisms. Berns et al. (2008) varied the probability of shock occurrence between $p = 1/6$ and $p = 1$ and found deviations from linear probability processing in visual, temporal, parietal, and frontal cortex, cingulate, insula and cerebellum. All of these activations were compatible with inverted S-shaped probability distortion. However, the exclusive testing with probabilities greater than zero prevented distinguishing inverted S-shaped from U-shaped distortions. U-shaped distortions would be more compatible with accounts proposing that reliable predictors of shock or no shock attract more attention than less reliable predictors (Mackintosh, 1975). The current tests with the full range of probabilities (from $p = 0.0$ to $p = 1.0$) revealed reward specific and differential encoding of fully inverted S and regular S-distortions in prefrontal regions that do not seem to be explained by attentional mechanisms.

The presently observed probability distortions occurred in well-controlled behavioral situations with actually experienced outcomes and differed partly from those observed in situations using verbal descriptions of choices (Paulus and Frank 2006). This distinction is important, as behavioral work has shown that we often underweigh experienced but overweigh described low probability outcomes, implicating regular S-distortions with experience and inverse S-distortions with description (Kahneman and Tversky, 1979; Kareev et al., 2002; Barron and Erev, 2003; Hertwig et al., 2004; Weber et al., 2004; Weber, 2006). In agreement with the notion of experience being an important factor in the representation of probability, the

present findings revealed not only description-compatible inverted S-shaped but also regular S-shaped distortions and experience-induced changes in neuronal probability distortions. The findings demonstrate the usefulness of behavioral tests with actually experienced outcomes for investigating basic neural mechanisms underlying probabilistic decision-making.

Relation to lesion studies

The present results are in good agreement with previous lesion studies nd transcranial magnetic stimulation that implicate prefrontal cortex in the processing of probabilistic outcomes (Bechara et al., 2000; Corbit and Balleine, 2003; Clark et al., 2004; Hornak et al., 2004; Fellows and Farah, 2005; Knoch, et al., 2006; Floden et al., 2008). Prefrontal lesions change risk-related behavior when patients repeatedly make decisions with probabilistic reward (Bechara et al., 2000; Clark et al., 2004; Floden et al., 2008). Conceivably, prefrontal lesions affect risk-related behavior by altering the coding of reward probability. Gambling behavior may become more prevalent with ventral prefrontal lesions because the experience-conforming underweighting of small probabilities no longer influences behavior.